

Blood Glucose Levels and Diabetes: A Simple Review

By Tish Doyle-Baker

Diabetes is a condition associated with varying blood glucose levels and results from an inability of the body to *regulate* blood glucose levels (BGL) and carbohydrate metabolism. Insulin and glucagon are hormones secreted by the islet cells of Langerhans within the pancreas. Insulin is secreted by the Beta cells and Glucagon is secreted by the Alpha cells. They are both secreted in response to blood glucose (BG) levels, but in opposite fashion. This article will be a simply review of blood glucose regulation, measurement and diagnosis.

How are blood glucose levels regulated?

When the level of BG is high, insulin is released from the pancreas into the blood stream. Insulin then enables both the transport of glucose and the storage of glucose. When BGL are low, glucagon is released by the pancreas and this stimulates the liver to produce glucose. In both cases normal glucose levels are achieved. A general rule of thumb is that BGL rise when food is eaten and decrease with insulin secretion and exercise. Juggling all three, food, insulin and exercise is challenge sometimes.

How do abnormally high levels of BGL occur?

An increase in BGL can occur when no insulin is being produced and when insulin production by the pancreas is insufficient, and/or when the body is resistant to the effects of insulin. Diabetes is characterized by recurrent or persistent hyperglycemia, i.e., high levels of glucose in the blood.

What is insulin resistance?

Insulin resistance is the inability of the body to respond appropriately to insulin. The term 'Insulin Resistance Syndrome' occurs when glucose does not readily enter the insulin target tissues, primarily muscle & adipose. This results in the subsequent rise of BG. One of the main causes of insulin resistance is obesity. Chronically high insulin levels inhibit adipose tissue, i.e. fat cells, from releasing their energy stores. Exercise improves insulin sensitivity and reduces the effects of hyperinsulinemia, i.e., high levels of insulin in the blood and subsequently improves an individual's ability to lose weight.

What units are used to measure BG?

BG is measured in Canada using the World Standard units of mmol/L (number of milli molar of glucose in one litre of blood). The United States uses the traditional or standard measure of mg/dl (milligrams of glucose in one decilitre (100 millilitres) of blood). It is important to know the conversion method because much of the research on diabetes and exercise originates in the USA. To convert mg/dl of glucose to mmol/L of glucose, divide # by 18 or multiply by 0.055. To convert mmol/L to mg/dl of glucose, multiply # by 18.

How is Diabetes diagnosed?

Diabetes can be diagnosed through the presence of symptoms such as fatigue, excess thirst, weight loss, frequent urination, and mood changes and is confirmed by the following three tests. A fasting plasma glucose level at or above 7.0 mmol/L, a glucose tolerance test, i.e. a plasma glucose at or above or 11.1 mmol/L, two hours after a 75 gram oral glucose load, or a random plasma glucose at or above or 11.1 mmol/L. A fasting BG is the most commonly used diagnostic criteria because of the ease of measurement and time efficiency. A positive result for diabetes usually involves two

tests on different days and by definition, this could be two fasting glucose measurements at or above 7.0 mmol/L.

What are the recommended levels of BG before and after a meal?

BGL needs to be within a narrow range for our bodies to work effectively. Food therefore, raises BGL. The diabetic will have BG range of 4.0 – 7.0 mmol/L before eating which will rise to 5.0 – 10.0 mmol/L two hours after eating. A non diabetic individual will have BGL range of 4.0 – 6.0 mmol/L before eating and this will rise to 5.0 – 8.0 mmol/L two hours after eating.

How can 'glycemic control' be monitored?

Monitoring BG is essential and for the diabetic this should occur before and after meals using a glucose monitor. Glycemic control can also be tracked over the long term by the measuring the amount of glucose attached to red blood cells. This is called glycosylated hemoglobin (*HbA_{1c}*). HbA_{1c} or A_{1c} is the average BGL over the preceding 90 days (approximately). The current recommended goal for A_{1c} in diabetes is <7.0%, which is defined as 'good glycemic control'. Diabetics who have A_{1c} levels within this range have a significantly lower incidence of complications from diabetes (retinopathy and diabetic nephropathy), and heart disease (atherosclerosis).

What effect does exercise have in lowering blood glucose levels?

In general, exercise lowers BGL and therefore there maybe the need to make adjustments to insulin/medications and food intake. A quick-acting source of glucose, i.e. six lifesavers, a glucose monitor, and water should always be available during exercise. BG should be monitored pre, during and post exercise. When working with diabetics and exercise there is the need to be familiar with symptoms of both high and low BG. As exercise intensity and duration increases, the risk of developing hypoglycaemia, i.e. low glucose in the blood, increases. It may not happen during exercise, but can occur four to six hours after the exercise session. This is why diabetics are often told to avoid exercising late at night, since a hypoglycaemia event could occur when they are sleeping at night.

What symptoms are associated with hypoglycaemia?

Symptoms of hypoglycaemia may include: hungry, feeling shaky, light-headed, nervous or irritable, sweaty, weak, nauseous, rapid heart beat, confused or a numbness of tingling in the tongue or lips. It is important to note that not all diabetes have symptoms of low hypoglycaemia.

In summary, glucose is the main source of fuel for the brain. It is common sense that varying levels of BG are going to impair brain function and general levels of performance. Eating complex carbohydrates such as whole grains, and vegetables that contain fibre and partaking in habitual exercise allows the body to utilize glucose as an energy source. Both are effective ways of avoiding BG spikes and drops. There is no cure for diabetes but it can be managed through a carefully balanced diet, exercise and insulin medication. Juggling all three can be hard work however; conscientious management of BGL over a life time decreases the threat of insulin resistance and progress of this to Diabetes.

The following exam is based on Dr. Tish Doyle-Baker's article

1. When blood glucose levels are high which hormone is released from the pancreas?
 - a. Glucagon
 - b. Cholesterol
 - c. Fatty acids
 - d. Insulin

2. Hyperinsulinemia is defined as?
 - a. high levels of glucose in the blood
 - b. high levels of glucagon in the blood
 - c. high levels of insulin in the blood
 - d. high levels of sugar in the blood

3. The current recommended value for "good glycemic control" using A₁C in individuals with diabetes is:
 - a. <8.5%
 - b. <6.5%
 - c. <7.0%
 - d. <5.0%

4. Convert the fasting plasma glucose level of 126 mg/dl to the world standard units of mmol/L?
 - a. 6.1
 - b. 7.0
 - c. 11.1
 - d. 4.0

5. Insulin resistance is strongly associated with obesity and physical inactivity?
 - a. True
 - b. False

6. The name of the diabetes diagnostic test that uses a 75 gm glucose load is called?
 - a. random plasma glucose
 - b. glucose tolerance
 - c. fasting plasma glucose
 - d. dipstick urine test

7. The current recommended goal for A₁C in diabetes is <7.0%, which is defined as 'good glycemic control'.
 - a. =8.0%
 - b. >7.0%
 - c. <5.2%
 - d. <7.0%

8. The fitness instructor should be familiar with both symptoms of high and low blood glucose when working with a diabetic client?
 - a. True
 - b. False

9. One effective method of avoiding blood glucose spikes and drops is?
 - a. Exercising on an empty stomach
 - b. Eating junk food
 - c. Choosing complex carbohydrates and partaking in habitual exercise
 - d. Not exercising

10. Glucose is the body's main source of energy?
 - a. True
 - b. False